PugetSoundPartnership
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Identification, Definition and Rating of Threats to the Recovery of Puget Sound

Technical Memorandum

November 2009

Authors of This Memorandum

This technical memorandum was prepared by members of the Puget Sound Partnership's Open Standards project ream, including:

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November 6, 2009

Dear Reviewer:

This is one of a series of technical memoranda released by the Partnership in conjunction with the 2009 State of the Sound Reporting.[1] These technical memoranda present the current products of work by staff from the Partnership and additional entities to implement Action Agenda activities addressing the development of the Partnership's performance management system (Action Agenda Chapter 3, Section E.1).

The audience for these memoranda includes the leadership of the Partnership; implementers of Action Agenda actions; elected officials, decision-makers and funders tracking progress in implementing the Action Agenda; and members of the scientific community whose work addresses the Puget Sound ecosystem or elements of it.

Outcomes we hope to achieve with these memoranda include:

- Broad ownership of the formative steps toward accountability for and adaptive management of the Action Agenda
- Maintained or increased levels of advocacy for the performance management system as a tool for helping ensure our investments are strategic and effective
- Awareness of technical, policy, and programmatic assumptions that are driving the Action Agenda, and the needs and opportunities to address inaccurate assumptions
- Early recognition of what will be used as performance measures, status indicators, benchmarks and targets to measure progress toward 2020 goals
- An initial sense of the implications of this work for key 2010 activities including budget development for the 2011-2013 biennium and consideration of the need to revise strategies in the 2008 Action Agenda

These technical memoranda represent an important advance toward having the performance management system assembled and informing strategic decisions by mid-2010. The Partnership is using the technical memorandum format to solicit feedback on the initial steps toward assembling the performance management system for the Action Agenda. The three memoranda focus on the application of the framework provided by the Open Standards for the Practice of Conservation. The parts of the framework addressed in these memoranda include: identification and rating of threats

[1] This 2009 report meets the statutory reporting requirements for the "State of the Sound Report."

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to the 2020 goals; identification of ecosystem components and their indicators; and development of results chains linking strategies and actions to threats and ecosystem components.

Each memorandum includes a set of specific guidance questions that will serve as a guide for focusing the review. While reviewer feedback on the entirety of the content is welcome, feedback that addresses the guidance questions directly will be the most useful and relevant in informing future decisions driving the form and function of the performance management system. The feedback the Partnership receives will be used to both refine the material presented and help us set a prioritized work plan that will focus our work on building the performance management system.

To facilitate timely incorporation of review feedback into the next steps of the work, **comments are due to the Partnership by December 4, 2009**. Comments can be submitted to the Partnership at actionagenda@psp.wa.gov. Comments can also be sent through the regular mail to the Partnership at the following address:

Martha Neuman
Puget Sound Partnership
PO Box 40900
Olympia, WA 98504

Thank you for your interest in advancing the development of the performance management system for the Action Agenda. We look forward to working with you in the coming months to build the foundation for a robust and functional system that will advance our shared goal of a clean and healthy Puget Sound ecosystem by 2020.

Sincerely,

David D. Dicks
Executive Director

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Guidance Questions for Reviewing this Memorandum

1. Are the direct-threat categories appropriate?
2. Are there additional direct-threat categories needed?
3. Are the threat definitions accurate?
4. Are the threat categories appropriately discrete or should they be grouped or split differently?
5. Is there new information – not reflected within the Action Agenda threats chapter regarding threats to Puget Sound Basin ecosystem – that should be accounted for within a threat rating? If so, please provide citations or references for this information or data.
6. Are there aspects of the threat rating process that need to be changed/adapted to support credible application to Puget Sound? If so, please provide the rationale for the suggested change(s).
7. Do the results of the 2009 threat rating exercise conflict with existing technical information regarding the scope, severity, or irreversibility of the rated threats? Please provide citations or references to support your response, as well as specific recommendations as to how a threat rating may change in response to the technical information.

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1. Introduction

This technical memo summarizes a 2009 regional threat rating completed for Puget Sound using the Open Standards for the Practice of Conservation[1] (Open Standards) methodology. The Open Standards defines a direct threat as "primarily human activities that immediately affect an ecological component, but they can also be natural phenomena altered by human activities or natural phenomena whose impact is increased by human activities." The purpose of the 2009 regional threat-rating exercise was to consistently apply the Open Standards threats taxonomy and threat-rating system to identify and evaluate the direct threats to Puget Sound ecosystems. The 2009 regional threats rating for Puget Sound does not reflect any new data or analyses, beyond what was compiled within the 2008 Action Agenda. It does not encompass rating at the smaller, Action Area scale, although the scale of a threat-rating exercise can affect conclusions about the magnitude of a specific threat.

Chapter 2 of the 2008 Action Agenda summarizes the status of the Puget Sound ecosystem and what significantly threatens its health. Although the type and magnitude of threats to Puget Sound ecosystems vary in scale and complexity, the origin of most direct threats is typically related to human activities. Over the past 150 years, the human population of Puget Sound has grown from 50,000 to 4 million people resulting in the destruction or alteration of many terrestrial, freshwater and marine habitats and associated food webs. The 2008 Action Agenda reflected considerable agreement among regional scientists and community leaders that residential, commercial and industrial development, resulting in the alteration and loss of habitat, as well as the ongoing input of pollution into our waterways, are the most immediate and pervasive threats to the ecosystem.

Understanding threats is a critical step in many stages of the ecosystem recovery process. This knowledge can help establish geographic priorities, assist with developing strategies to address primary issues, and help with the development of measures to determine whether a specific strategy or activity is achieving its desired results. Threat assessment is vitally important, yet is particularly difficult for large complex systems like Puget Sound, where ecosystems are managed for both ecological and human well-being outcomes.

In particular, what constitutes a threat to the health of ecosystem process, structure, or function may directly or indirectly provide a benefit to human populations. For example, new development and associated construction activities may result in land-cover conversion and altered hydrology, but development and associated landscape conversion has traditionally supported local and regional

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[1] For more information regarding the Open Standards for the Practice of Conservation, please see www.conservationmeasures.org

economies. A second example relates to agricultural activities. Productive farmland typically requires fertile soil, access to freshwater resources, and relatively flat topography – characteristics common to many of our region's floodplain environments that are also capable of supporting varying levels of development, transportation corridors, and habitat restoration in support of salmon recovery.

These two examples provide a very small indication of the broad range of tradeoffs, or direct and indirect consequences associated with the effects of human population growth and land-use activities on human and natural systems of Puget Sound. As the region's population continues to grow and pressures on the natural environment become more pronounced, it is increasingly important that we improve our understanding of the many ways in which human populations in the Puget Sound region benefit from healthy local, regional and global ecosystems, as well as the many ways in which societal actions can directly and indirectly threaten or enhance ecosystem health.

During spring/summer 2009, Puget Sound Partnership staff, staff from Action Agenda implementing entities, and consultants identified focal ecological components – habitats, species, and ecological processes – that best represent the diversity of ecological systems within the Puget Sound Basin[2]. Next, this working group completed a regional threat rating exercise, as informed by the threats/drivers identified within the 2008 Action Agenda, to provide a consistent approach to characterizing threats and summarizing their impact upon focal ecological components of Puget Sound[3]. The 2009 regional threat rating did not account for the complex relationships and trade-offs associated with direct threats and human populations, but instead provided a focused assessment of how each direct threat affects the diversity of ecological systems within Puget Sound.

This technical memorandum is structured to first present 27 direct-threat categories — a formalized taxonomy of threats to Puget Sound ecosystems — intended to reflect the Open Standards direct-threat classification system as well as threats and drivers identified within the 2008 Action Agenda. Next, it outlines the 2009 methods employed to generate a preliminary rating of direct threats to Puget Sound ecosystems and their recovery. Results from the preliminary 2009 regional threat rating are presented by threat category, across all ecological components. This technical memorandum concludes with recommendations for next steps to guide a 2010 work program to further refine the region's knowledge regarding threats to Puget Sound ecosystem health and recovery.

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[2] For a more complete summary of Puget Sound's ecological and human dimensions components, please see the 2009 Technical Memo entitled, *Identification of Ecosystem Components and Their Indicators and Targets.*

[3] Contributors to the 2009 Regional Threat Rating included: Martha Neuman; David St. John; Mary Beth Brown; Scott Redman; Jim Cahill; Paul Bergman; Mary Ruckelshaus; Ken Currens; Rebecca Ponzio; Jennifer Knauer; Josh Baldi; Randy Shuman; Michael Rylko; Sandie O'Neill; Jacques R. White,; Kari Stiles; Michael Jacobson; Nick Salafsky; Caroline Stem; Trina Wellman; Kirsten Evans; Bridget Moran

2. Direct Threats to Puget Sound Ecosystems

2.1 2008 Action Agenda Identification of Threats/Drivers

The 2008 Action Agenda defined 'threat' as any activity that has altered the ecosystem in the past or present, or is likely to do so in the future. Chapter 2 of the 2008 Action Agenda summarized six broad categories of threats to Puget Sound ecosystem health: natural and external drivers, habitat alteration, pollution, surface/groundwater impacts, artificial propagation, harvest and invasive species. Changes to Puget Sound ecosystems are also driven by natural processes such as: weather, volcanoes, earthquakes, ocean circulation patterns, and climate change and its ancillary impacts. These natural phenomena often amplify the many pressures facing Puget Sound ecosystems. Further compounding these challenges is the fragmented set of institutions now in place to manage natural resources. A more detailed summary of these threats and drivers for Puget Sound ecosystems were summarized in a supplement to the 2008 Action Agenda that identified primary threats/drivers for Puget Sound ecosystems[4].

2.2 2009 Taxonomy of Direct Threats for Puget Sound

Step One of the Open Standards Project Management Cycle includes the identification of direct threats to the focal components (targets) of Puget Sound ecosystems. The Open Standards defines a direct threat as primarily human activities that immediately affect an ecological component, but it can also be natural phenomena altered by human activities or natural phenomena whose impact is increased by human activities. Building upon the threat-analysis work completed in support of the 2008 Action Agenda, Puget Sound Partnership staff, staff from Action Agenda implementing entities, and consultants used the Open Standards threats taxonomy to organize the threats/drivers identified within the 2008 Action Agenda into 27 direct threat categories. This taxonomy of direct threats to Puget Sound recovery guided the 2009 regional threat rating for Puget Sound and is summarized within Table 1.

[4] http://www.psp.wa.gov/downloads/DRAFT_ACTION_AGENDA_2008/Q2_2_Supplemental_materials.pdf

Table 1. Taxonomy of Direct Threats for Puget Sound (Sources: Conservation Measures Partnership Proposed Classification of Direct Threats[5]; 2008 Action Agenda)

DIRECT THREAT CLASS	PUGET SOUND DEFINITIONS
Agriculture & Livestock Grazing	This threat class includes: • non-timber crops planted for food, fiber, or other uses • domestic animals raised in one location and their physical impacts to soils, vegetation, and associated surface water resources (effluent) • nurseries • ditching in support of agriculture • hobby farms and agricultural zoned lands
Air Pollution & Atmospheric Deposition	This threat class includes: • atmospheric pollutants from airborne point and non-point sources, both domestic and international • acid rain • smog from vehicle emissions and industrial sources • nitrogen deposition • radioactive fallout • wind dispersion of pollutants or sediments • smoke from forest fires or wood stoves • carbon dioxide emissions leading to ocean acidification
Aquaculture	This threat class includes: • aquatic animals raised in one location (e.g., net pens) • hatchery salmon allowed to roam in the wild (genetics, nutrients, sea lice) • hatchery operations (effluent, antibiotics, etc.) • shrimp or fin fish aquaculture • fish ponds on farms • seeded shellfish beds • artificial algal beds
Climate Change	This threat class includes: • threats from long-term climatic changes, which may be linked to global warming and other severe climatic/weather events that are outside of the natural range of variation, or can cause the extinction or extirpation of a vulnerable species or obliterate a habitat type • climatic events increasing in frequency or intensity outside their natural range of variation due to human causes; related stressors include salinity change, sea level rise, snowpack change, ocean acidification, temperature change, amplification of invasive species, increased flooding
Dams, Levees & Tidegates	This threat class includes: • impeding or rerouting surface or subsurface hydrology through the placement, operation, or maintenance of a structure, either deliberately or as a result of other activities • dams, levees, revetments, tidegates and other freshwater shoreline armoring This threat class does not include water withdrawals & diversions, marine shoreline armoring, or overwater structures.
Derelict Gear & Vessels	This threat class includes: • abandoned and lost gear that continues to catch fish and alters habitat This threat class does not include marine habitat degradation that results from harvest of marine resources, which is accounted for within the direct-threat class, 'unsustainable fishing/harvesting'
Dredging & Dredged Material Disposal	This threat class includes: • gravel extraction and disposal from freshwater habitats • dredging in nearshore/marine environments in support of shipping lanes and marine transportation
Invasive Species and Other Problematic	This threat class includes: • threats from non-native plants, animals, pathogens/microbes, or genetic materials that have or are predicted to

[5] For additional information regarding the taxonomy of direct threats, please see www.conservationmeasures.org

Species - Terrestrial	have harmful effects on biodiversity following their introduction, spread and/or increase in abundance
Invasive Species and Other Problematic Species -Freshwater	This threat class includes: • threats from non-native plants, animals, pathogens/microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance
Invasive Species and Other Problematic Species - Marine	This threat class includes: • threats from non-native plants, animals, pathogens/microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance • ballast water
Large Scale Timber Harvest	This threat class includes: • industrial or large-scale commercial harvesting of trees and other woody vegetation for timber, fiber or fuel • associated forest roads, effluent and runoff, including pesticides
Military Exercises	This threat class includes: • Land-based maneuvers and training with tanks and other military vehicles • Defoliation • Munitions testing • Underwater detonations and submarine maneuvers This threat class does not include the impervious surfaces and development associated with permanent military bases, these are captured within the residential, commercial, port and shipyard threat class.
Mineral / Gravel Mining	This threat class includes: • Exploring for, developing, and producing minerals and rocks (quarries, gold, etc) This threat class does not include extraction of gravel from river or stream beds.
Oil & Hazardous Spills	This threat class includes: • accidents on land and water that result in water-borne pollutants or toxics in natural systems This threat class does not include pollutants from stormwater, wastewater treatment plants, CSOs, or other contaminant sources.
Onsite Sewage Systems	This threat class includes: • sewage and leachates from residences not connected to a municipal system (septics, small private systems, and everything with a drain field) • nutrients, toxic chemicals and/or sediment from these onsite systems
Point Source Pollution	This threat class includes: • industrial, military and commercial point source pollution • cruise ships and other commercial & industrial boat discharge • legacy toxic sites in the marine and near-shore environments This threat class does not include surface water runoff, wastewater discharge, or air emissions.
Recreational Activities	This threat class includes: • nature-based recreational activities such as hunting, recreational fishing, beach access, hiking, cross-country skiing, mountain bicycling, rock climbing, bird watching, camping and swimming This threat class does not include commercial whale watching, commercial recreational activities or recreation boat discharge.
Recreational Marinas	This threat class includes: • marinas, jetties, docks, piers and other compact footprint structures This threat class does not include hull-cleaning and other NPDES regulated activities that occur in marinas.
Residential, Industrial, Commercial, Port & Shipyard Development	This threat class includes: • developed portions of the environment, or other non-agricultural land uses with a substantial footprint, such as those associated with residential, commercial, and industrial land uses • landfills, ports, military shipyards, and log rafting (only habitat destruction) This threat category does not include transportation infrastructure or run-off generated from developed portions of the environment.
Roads, Transportation & Utility Infrastructure	This threat class includes: • surface transport on roadways and dedicated tracks • long narrow transport corridors and the vehicles that use them

- transport of energy and resources
- effects of construction on habitat, including ongoing fragmentation

This threat class does not include: forest logging roads, ancillary roads in urban areas, shoreline armoring runoff, effluent, or air emissions.

Shoreline Armoring

This threat class includes:

- bulkheads, riprap, and other linear shoreline modifications associated with roads, railroads, residential development
- near-shore and freshwater shoreline armoring which supports transportation and utility ROWs

This threat class does not include: flood control shoreline armoring (levees and revetments) The footprints associated with transportation and utility ROWs are included within the Transportation and Utility Infrastructure threat class; this threat class includes only the shoreline armoring, which often supports those ROWs.

Surface Water Loading & Runoff from the Built Environment

This threat class includes:

- activities regulated by NPDES
- stormwater water runoff, including toxics, nutrients, pathogens, etc
- runoff from roads, rail corridors, and transportation infrastructure
- non-point source pollution from marina infrastructure + land-based recreational boat maintenance practices
- best management and containment practices for residential, commercial, and industrial land uses

This threat class does not include loading from septic systems, agriculture or forestry practices.

Unsustainable Fishing / Harvesting

This threat class includes:

- overharvesting and bycatch of fish and shellfish from both legal and illegal practices
- marine/freshwater habitat destruction from fishing practices

This threat class does not include derelict gear or recreational fishing.

Vessel Traffic & Interaction

This threat class includes:

- commercial transport and tourist ships on and in freshwater and marine waterways
- shipping lanes
- commercial whale-watching vessels
- wakes from cargo ships
- anchor damage from dive boats

This threat class does not include recreational boating in freshwater and marine waterways.

Wastewater Treatment Plant Discharge & CSOs

This threat class includes:

- water-borne sewage from housing and urban areas that include nutrients, toxic chemicals , pathogens, and/or sediments
- Municipal wastewater treatment facilities
- Combined sewer overflows (CSOs)

This threat class does not include bio solids applied in terrestrial environments.

Water Withdrawals & Diversions

This threat class includes:

- extraction and diversion of water in support of residential, industrial, commercial, and other rural and municipal uses
- changing water flow patterns, such as instream flows, from their natural range of variation either deliberately as a result of water supply or flood management operations

Governmental Arrangements

This threat class is more precisely an 'indirect threat or driver' and includes formal, legally mandated, informal or voluntary relationships between local, state, and federal agencies and entities; interactions between local, state, and federal agencies and entities; results and outcomes from actions taken by individual agencies and entities over time.

This indirect class of threats does not include NGOs, private property owners, and other non-governmental groups.

Sub-categories of this indirect threat class include:

- Cross-cutting and ecosystem scale actions: some scientific endeavors such as some monitoring efforts and modeling, some broad planning exercises and documents such as HCPs, some permits aimed at addressing multiple threats, integration efforts such as harvest, hatching and restoration in the regional salmon recovery plan.
- Performance system that addresses a central part of the Partnership's mission
- Funding issues that are not specific to a specific threat
- Education and outreach efforts not targeted to a specific threat

3. Threat Rating Methods

The Open Standards provides numerous approaches to the identification and rating of direct threats and recommends using methods that are appropriate to the geographic and management context. An ideal threat-rating system will provide consistent comparisons of threats at both one site over time and across different sites. Accordingly, threat measurement needs to be consistent, reliable and unbiased, combinable, scalable, powerful yet easy to use, and cost effective. Threat-rating methods used to guide the 2009 Puget Sound regional threat rating were developed by the Conservation Measures Partnership and The Nature Conservancy; these relatively simple methods are combinable, scalable and are automated by an open-source computer program, Miradi.

The 2009 evaluation and rating of direct threats to ecosystem health were conducted at a Puget Sound basin scale, to reflect the geographic scope of the Action Agenda. This regional approach to direct-threat evaluation takes into account the physical scope, scale and complexity associated with Puget Sound ecosystems, as well as the numerous direct and indirect threats, drivers, pressures, and other ecosystem-shaping forces. Results from the regional threat rating were compared and reconciled with subregional threats/drivers information gleaned from the 2008 Action Area Profiles (2008 Action Agenda) and other technical reports.

The scale at which threat rating is undertaken influences the results. At the scale of the entire Puget Sound, a threat may be rated low because it is significant in only one or two localized instances. If such a threat was rated at a smaller scale it would likely be rated at a higher level of threat for that smaller geography. Most importantly, the 2009 regional threat rating reflects best professional judgment drawn from Puget Sound Partnership staff, staff from Action Agenda implementing entities, and consultants with detailed familiarity with the Action Agenda and the Puget Sound ecosystem.

Methods guiding the 2009 rating of direct threats to ecosystem health included the evaluation of twenty-six direct-threats (see table 1) at a Puget Sound Basin scale upon eleven focal ecological components, a suite of ecosystem features that represent and encompass Puget Sound ecosystems[6]:

1. freshwater habitats
2. marine birds
3. marine fish
4. marine mammals
5. marine invertebrates
6. marine shorelines
7. marine waters

[6] For additional information regarding ecological components, please see the *Identification of Ecosystem Components and Their Indicators and Targets, 2009 Puget Sound Partnership Technical Memo*

8. river deltas and coastal embayments
9. salmon
10. terrestrial birds
11. terrestrial habitats

Six additional focal ecological components were identified through consultation with regional stakeholders after completion of the 2009 regional threats rating and therefore were not rated as part of the 2009 threats assessment. These ecological components are presented as 'not rated' within the summary threat-rating tables located in the next section of this technical memo, but are being considered for rating in the future.

3.1 2009 Regional Threat-Rating Process

A preliminary Puget Sound regional threat rating was completed in a workshop setting in May 2009, as part of a Partnership-sponsored Open Standards workshop. Puget Sound Partnership staff, staff from Action Agenda implementing entities, and consultants worked collaboratively with scientists, policymakers, planners, and other conservation professionals from the region to generate a first iteration of the regional threat rating. Following the workshop, this rating was refined through small group work sessions and consultations with specific topical experts. Miradi, open-source software that assists with the implementation of the Open Standards, was used to compute the Puget Sound regional threat rating[7].

3.2 Regional Threat Rating Values and Criteria

The impacts associated with each direct threat, upon 11 focal ecological components, were evaluated using three criteria of scope, severity and irreversibility. Values for each direct-threat criterion were entered into Miradi, which employs algorithms to generate a threat rating of Very High, High, Medium or Low for individual ecological components, as well as across components to derive an 'overall' threat rating. If work-group members noted that there was not a significant relationship between a direct-threat class and a specific ecological component, values were not entered into Miradi and the threat was rated 'Minimal/No Effect' to reflect that the ecological component in question is minimally or not affected by the direct threat. Three criteria and associated values used to generate the 2009 Puget Sound threat rating are further defined below.

Scope (Area) – Most commonly defined spatially as the proportion of the focal component that can reasonably be expected to be affected by the threat within ten years given the continuation of current

[7] For additional information regarding Miradi and the algorithms it employs, please see a working paper entitled, "Measuring Threat Magnitude: A Comparison of Existing Methods and Recommendations for a Standard System for Assessing the Scale of Threats to Biodiversity" (Conservation Measures Partnership, Aug 2007). *www.fosonline.org*

circumstances and trends. For ecosystems and ecological communities, measured as the proportion of the ecological component's occurrence. For species, measured as the proportion of the component's population.

4 = Very High: The threat is likely to be pervasive in its scope, affecting the component across all or most (71-100%) of its occurrence/population.

3 = High: The threat is likely to be widespread in its scope, affecting the component across much (31-70%) of its occurrence/population.

2 = Medium: The threat is likely to be restricted in its scope, affecting the component across some (11-30%) of its occurrence/population.

1 = Low: The threat is likely to be very narrow in its scope, affecting the component across a small proportion (1-10%) of its occurrence/population.

Severity – Within the scope, the level of damage to the component from the threat that can reasonably be expected given the continuation of current circumstances and trends. For ecosystems and ecological communities, typically measured as the degree of destruction or degradation of the component within the scope. For species, usually measured as the degree of reduction of the component population within the scope.

4 = Very High: Within the scope, the threat is likely to destroy or eliminate the component, or reduce its population by 71-100% within ten years or three generations.

3 = High: Within the scope, the threat is likely to seriously degrade/reduce the component or reduce its population by 31-70% within ten years or three generations.

2 = Medium: Within the scope, the threat is likely to moderately degrade/reduce the component or reduce its population by 11-30% within ten years or three generations.

1 = Low: Within the scope, the threat is likely to only slightly degrade/reduce the component or reduce its population by 1-10% within ten years or three generations.

Irreversibility – The degree to which the effects of a threat can be reversed and the component affected by the threat restored, if the threat no longer existed.

4 = Very High: The effects of the threat cannot be reversed and it is very unlikely the component can be restored, and/or it would take more than 100 years to achieve this (e.g., wetlands converted to a shopping center).

3 = High: The effects of the threat can technically be reversed and the component restored, but it is not practically affordable and/or it would take 21-100 years to achieve this (e.g., wetland converted to agriculture).

2 = Medium: The effects of the threat can be reversed and the component restored with a

reasonable commitment of resources and/or within 6-20 years (e.g., ditching and draining of wetland).

1 = **Low:** The effects of the threat are easily reversible and the component can be easily restored at a relatively low cost and/or within 0-5 years (e.g., off-road vehicles trespassing in wetland).

Chapter 4. 2009 Regional Threat Rating Results

4.1 Agriculture and Livestock Grazing

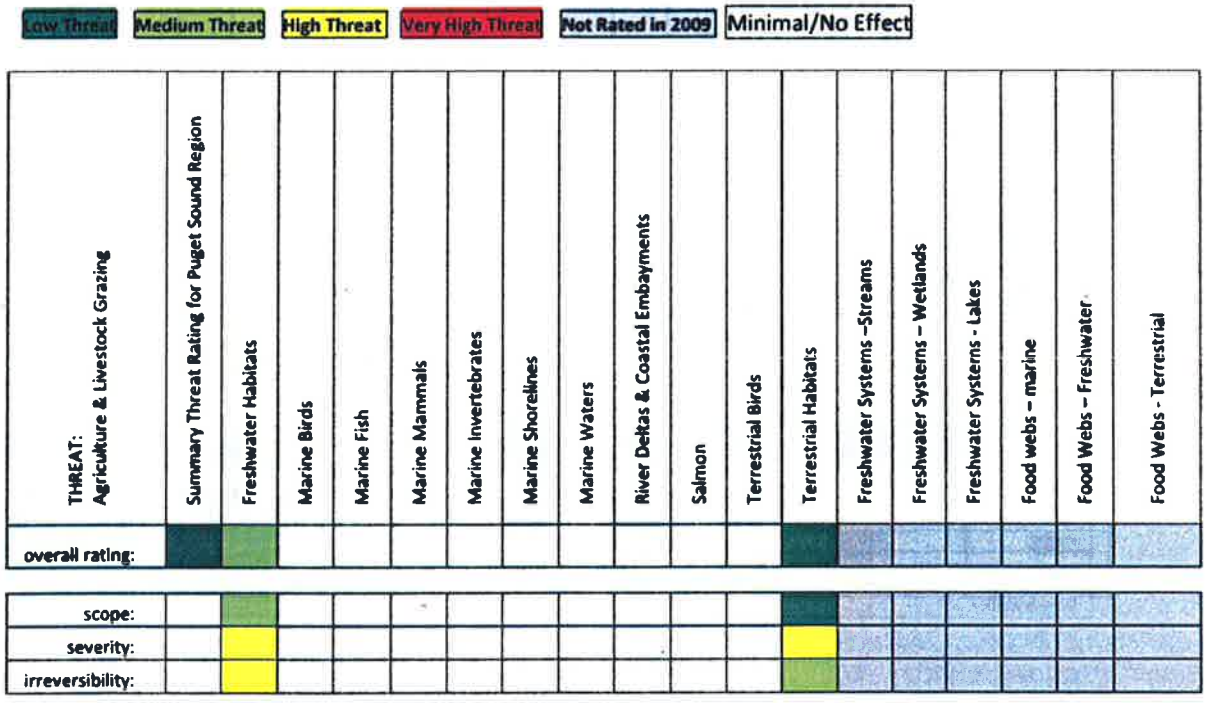
Overall Regional Threat Rating: Low Threat

Threat Definition: This threat class includes:

- non-timber crops planted for food, fiber, or other uses
- domestic animals raised in one location and their physical impacts to soils, vegetation, and associated surface water resources (effluent)
- nurseries
- ditching in support of agriculture
- hobby farms and agricultural zoned lands

Threat Rating Comments: This threat was rated for its direct effect upon ecological components; ratings were not intended to capture the many positive societal values gained from agricultural land uses. Many agricultural practices in Puget Sound occur in river valleys and floodplains, though some also take place in upland plateaus. As a result, the threat rating highlights two ecological components directly threatened by agricultural practices: freshwater habitats and terrestrial habitats.

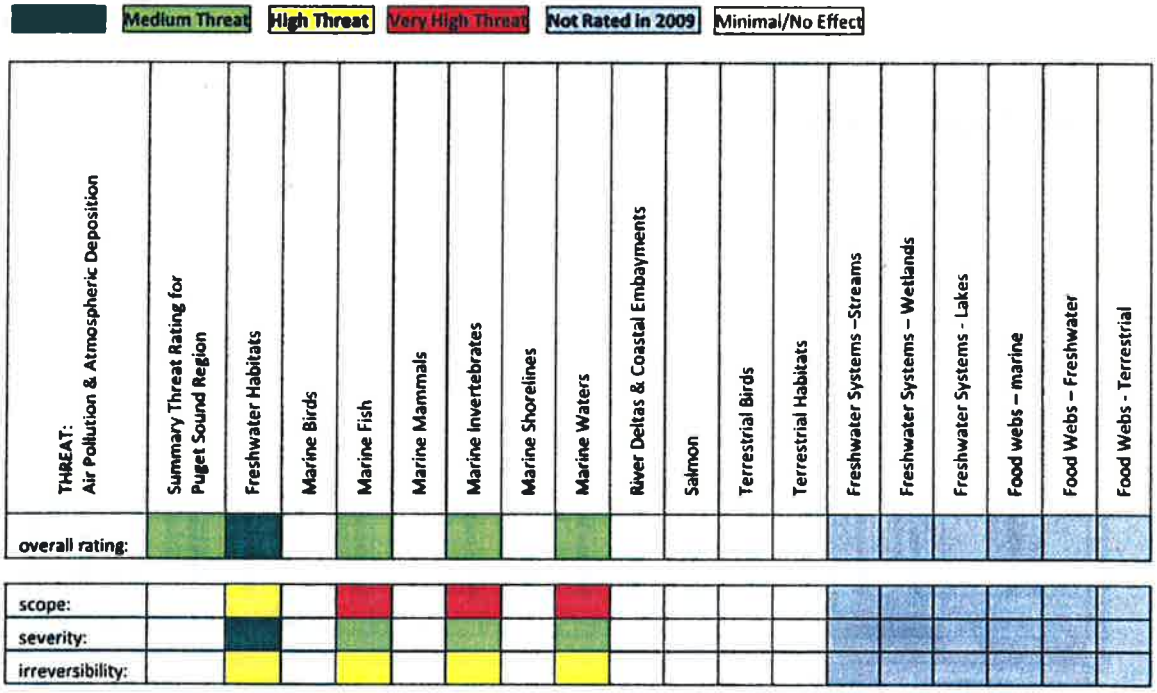
Figure 1. Regional Threat Rating Summary: Agriculture and Livestock Grazing



4.2 Air Pollution and Atmospheric Deposition

Overall Regional Threat Rating:	Medium Threat
Threat Definition:	This threat class includes: • atmospheric pollutants from airborne point and non-point sources, both domestic and international • acid rain • smog from vehicle emissions and industrial sources • nitrogen deposition • radioactive fallout • wind dispersion of pollutants or sediments • smoke from forest fires or wood stoves • carbon dioxide emissions leading to ocean acidification
Threat Rating Comments:	Air pollution sources and atmospheric deposition originate from within and outside of the Puget Sound Basin and may be trans-boundary in nature. Carbon dioxide emissions lead to ocean acidification and pose a direct threat to marine waters, species and habitats.

Figure 2. Regional Threat Rating Summary: Air Pollution and Atmospheric Deposition



4.3 Aquaculture

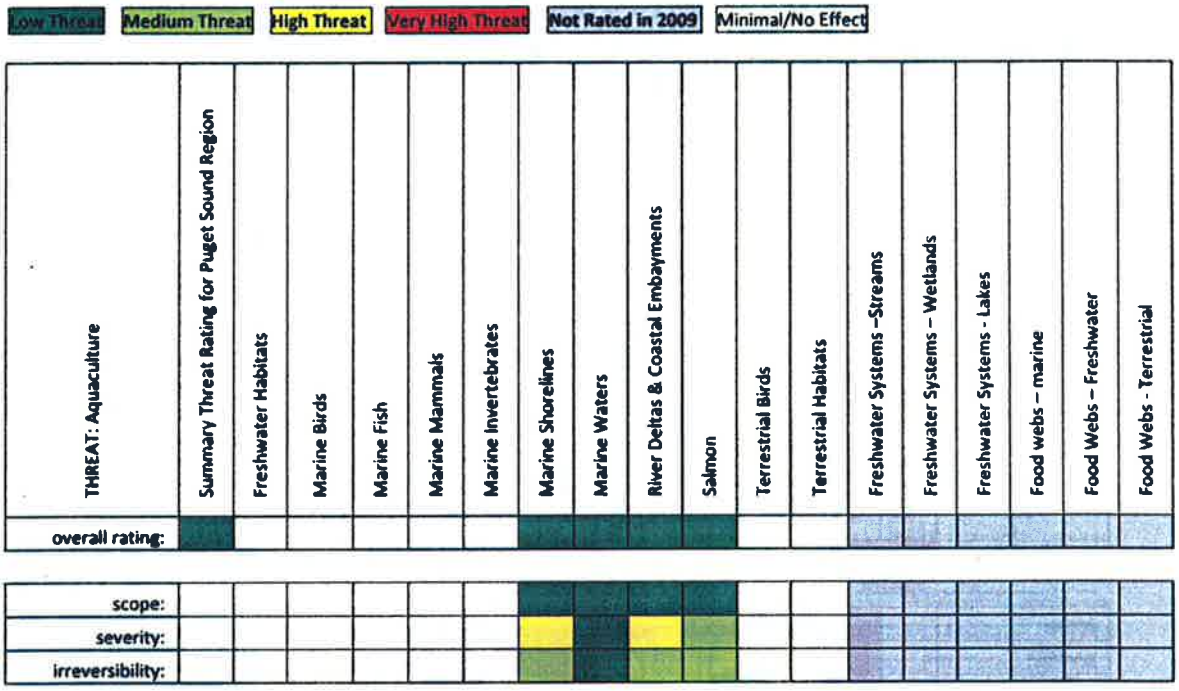
Overall Regional Threat Rating: Low Threat

Threat Definition: This threat class includes:

- aquatic animals raised in one location (e.g., net pens)
- hatchery salmon allowed to roam in the wild (genetics, nutrients, sea lice)
- hatchery operations (effluent, antibiotics, etc.)
- shrimp or fin fish aquaculture
- fish ponds on farms
- seeded shellfish beds
- artificial algal beds

Threat Rating Comments: This threat was rated for its direct effect upon ecological components; ratings were not intended to capture the positive societal values gained from aquaculture. Aquaculture was rated as a low direct threat to marine waters, marine shorelines, river deltas/coastal embayments and salmon primarily due to the effectiveness of current regulations governing aquaculture practices.

Figure 3. Regional Threat Rating Summary: Aquaculture



4.4 Climate Change

Overall Regional Threat Rating: Very High Threat

Threat Definition: This threat class includes:

- threats from long-term climatic changes which may be linked to global warming and other severe climatic/weather events that are outside of the natural range of variation, or can cause the extinction or extirpation of a vulnerable species or obliterate a habitat type
- climatic events increasing in frequency or intensity outside their natural range of variation due to human causes; related stressors include salinity change, sea level rise, snowpack change, ocean acidification, temperature change, amplification of invasive species, increased flooding

Threat Rating Comments: A changing global and Pacific Northwest climate interacts with the effects of human drivers and threats to Puget Sound ecosystems. Increased temperatures, changes in volume and timing of precipitation and stream flows, as well as a reduction in snowpack will have major implications for the region's water resources, ecosystem health, forests, fish and wildlife resources, and agricultural practices. A rise in sea level is likely and some portions of the Puget Sound nearshore and marine environments may experience increases in coastal erosion, landslides, inundation and flooding.

Figure 4. Regional Threat Rating Summary: Climate Change

4.5 Dams, Levees, and Tidegates

Overall Regional Threat Rating: High Threat

Threat Definition: This threat class includes:

- impeding or rerouting surface or subsurface hydrology through the placement, operation, or maintenance of a structure, either deliberately or as a result of other activities
- dams, levees, revetments, tidegates and other freshwater shoreline armoring

This threat class does not include water withdrawals & diversions, marine shoreline armoring, or overwater structures

Threat Rating Comments: This threat was rated high for its direct effect upon ecological components; ratings were not intended to capture the many positive societal values gained from dams, levees, and tidegates. This direct threat affects most of the Puget Sound Basin and the results in: the disconnection of rivers with their floodplains; habitats which do not support complex food webs; reduced biodiversity; and threatened survival of some species, such as salmon.

Figure 5. Regional Threat Rating Summary: Dams, Levees and Tidegates

Low Threat | Medium Threat | High Threat | Very High Threat | Not Rated in 2009 | Minimal/No Effect

THREATS: Dams, Levees & Tidegates	Summary Threat Rating for Puget Sound Region	Freshwater Habitats	Marine Birds	Marine Fish	Marine Mammals	Marine Invertebrates	Marine Shorelines	Marine Waters	River Deltas & Coastal Embayments	Salmon	Terrestrial Birds	Terrestrial Habitats	Freshwater Systems –Streams	Freshwater Systems – Wetlands	Freshwater Systems - Lakes	Food webs – marine	Food Webs – Freshwater	Food Webs - Terrestrial
overall rating:																		
scope:																		
severity:																		
irreversibility:																		

4.6 Derelict Gear and Vessels

Overall Regional Threat Rating: Low Threat

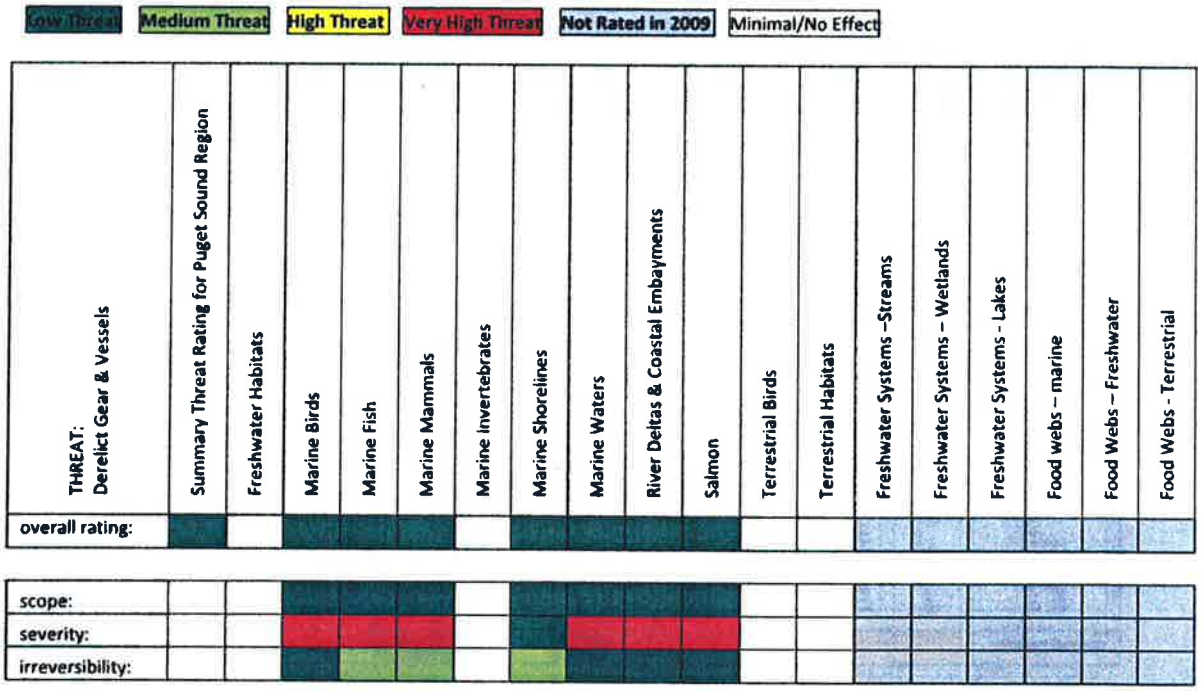
Threat Definition: This threat class includes:

- abandoned and lost gear that continues to catch fish and alters habitat

This threat class does not include marine habitat degradation that results from harvest of marine resources, which is accounted for within the direct threat class, 'unsustainable fishing/harvesting'

Threat Rating Comments: This threat directly affects a small percentage of the Puget Sound Basin's near-shore and marine waters, yet where derelict gear and vessels do exist there is habitat alteration and impacts to marine birds, marine fish, marine mammals, river deltas/coastal embayments, salmon, and marine foodwebs.

Figure 6. Regional Threat Rating Summary: Derelict Gear and Vessels



4.7 Dredging and Dredged Material Disposal

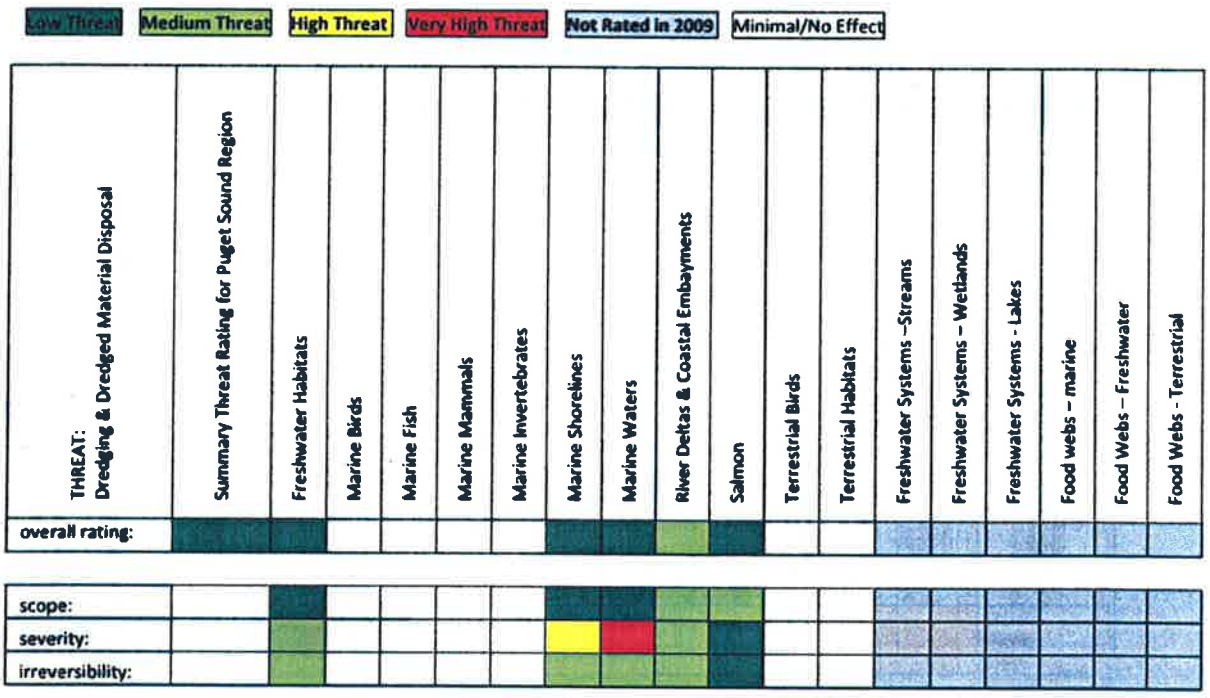
Overall Regional Threat Rating: Low Threat

Threat Definition: This threat class includes:

- gravel extraction and disposal of dredged materials in aquatic habitat
- dredging in near-shore/marine environments in support of shipping lanes and marine transportation

Threat Rating Comments: This threat was rated for its direct effect upon ecological components; ratings were not intended to capture the positive societal values gained from dredging and the disposal of dredged materials. This direct threat was rated low due to the effectiveness of laws and regulations which currently govern instream dredging and disposal of materials.

Figure 7. Regional Threat Rating Summary: Dredging and Dredged Material Disposal



4.8 Invasive Species - Terrestrial

Overall Regional Threat Rating: High Threat

Threat Definition: This threat class includes:

- threats from non-native plants, animals, pathogens/microbes, or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance

Threat Rating Comments: Invasive species often have a detrimental impact to native species and are identified as a principal risk to Puget Sound ecosystems[8]. Whether they are introduced deliberately or inadvertently, invasive species may out-compete native species for resources, prey upon native species, reduce the resiliency of ecosystems, and change the character of habitat. Climate change may exacerbate the threats posed by invasive species within the Puget Sound Basin. This direct threat was rated high for the Puget Sound Basin due to limited knowledge regarding the status and trends of established invasive species, risks posed by pathways by which new invasive species may be introduced, and the costs associated with prevention, eradication and control.

Figure 8. Regional Threat Rating Summary: Invasive Species - Terrestrial

[8] *State of Washington Natural Heritage Plan*, Washington State Department of Natural Resources, 2003

4.9 Invasive Species - Freshwater

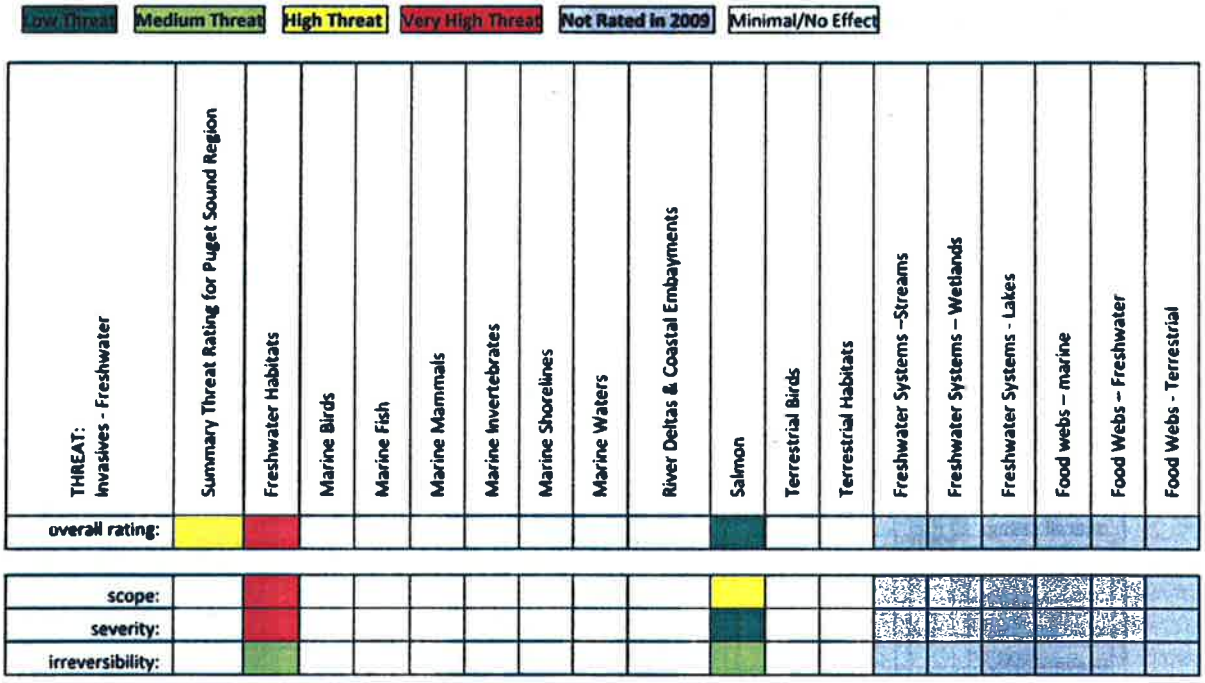
Overall Regional Threat Rating: High Threat

Threat Definition: This threat class includes:

- threats from non-native plants, animals, pathogens/microbes or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance

Threat Rating Comments: Invasive species often have a detrimental impact to native species and are identified as a principal risk to Puget Sound ecosystems[9]. Whether they are introduced deliberately or inadvertently, invasive species may out-compete native species for resources, prey upon native species, reduce the resiliency of ecosystems, and change the character of habitat. Climate change may exacerbate the threats posed by invasive species within the Puget Sound Basin. This direct threat was rated high for the Puget Sound Basin due to limited knowledge regarding the status and trends of established invasive species, risks posed by pathways by which new invasive species may be introduced, and the costs associated with prevention, eradication, and control.

Figure 9. Regional Threat Rating Summary: Invasive Species - Freshwater



[9] *State of Washington Natural Heritage Plan*, Washington State Department of Natural Resources, 2003

4.10 Invasive Species - Marine

Overall Regional Threat Rating: High Threat

Threat Definition: This threat class includes:

- threats from non-native plants, animals, pathogens/microbes or genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance
- ballast water

Threat Rating Comments: Invasive species often have a detrimental impact to native species and are identified as a principal risk to Puget Sound ecosystems[10]. Whether they are introduced deliberately or inadvertently, invasive species may out-compete native species for resources, prey upon native species, reduce the resiliency of ecosystems, and change the character of habitat. Climate change may exacerbate the threats posed by invasive species within the Puget Sound Basin. This direct threat was rated high for the Puget Sound Basin due to limited knowledge regarding the status and trends of established invasive species, risks posed by pathways by which new invasive species may be introduced, and the costs associated with prevention, eradication, and control.

Figure 10. Regional Threat Rating Summary: Invasive Species - Marine

Low Threat | Medium Threat | High Threat | Very High Threat | Not Rated in 2009 | Minimal/No Effect

THREAT: Invasives- Marine	Summary Threat Rating for Puget Sound Region	Freshwater Habitats	Marine Birds	Marine Fish	Marine Mammals	Marine Invertebrates	Marine Shorelines	Marine Waters	River Deltas & Coastal Embayments	Salmon	Terrestrial Birds	Terrestrial Habitats	Freshwater Systems –Streams	Freshwater Systems – Wetlands	Freshwater Systems - Lakes	Food webs – marine	Food Webs – Freshwater	Food Webs - Terrestrial
overall rating:																		
scope:																		
severity:																		
irreversibility:																		

[10] *State of Washington Natural Heritage Plan*, Washington State Department of Natural Resources, 2003

4.11 Large Scale Timber Harvest

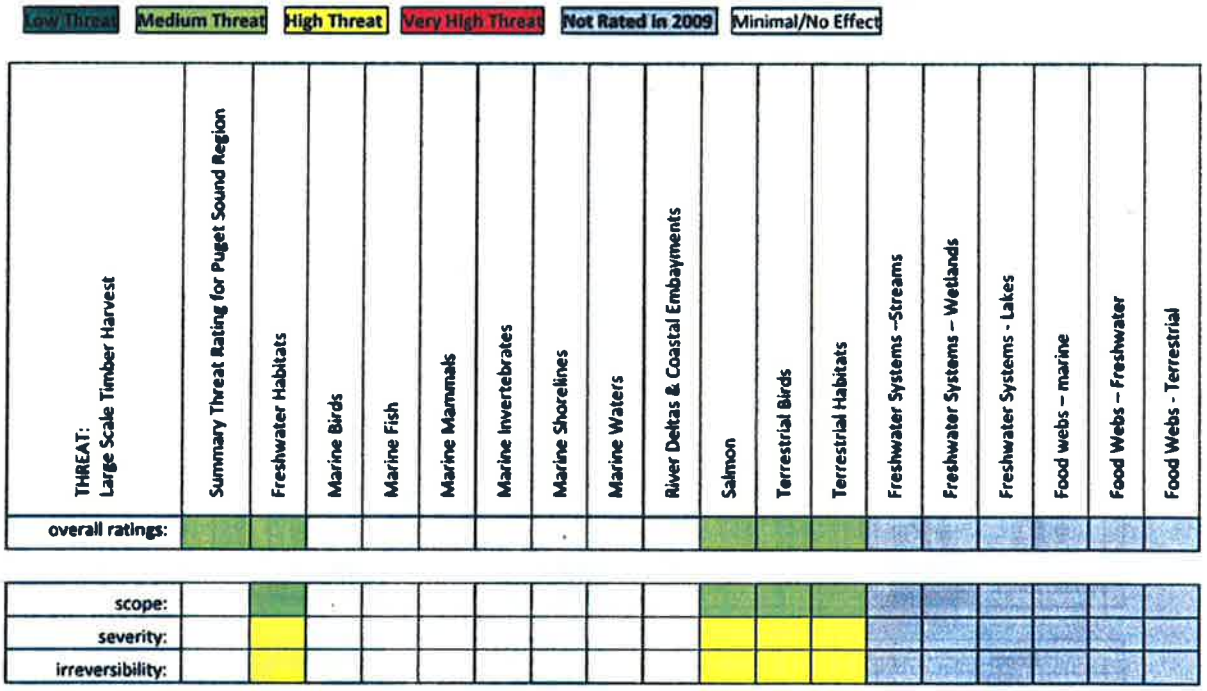
Overall Regional Threat Rating: Medium

Threat Definition: This threat class includes:

- industrial or large-scale commercial harvesting of trees and other woody vegetation for timber, fiber, or fuel
- associated forest roads, effluent and runoff, including pesticides

Threat Rating Comments: This threat was rated high for its direct effect upon ecological components; ratings were not intended to capture the many positive societal values gained from timber harvest. Large-scale timber harvest takes place in a subset of Puget Sound watersheds and is governed by many existing laws and regulations. This direct threat was rated medium due to the degree to which regulated, large-scale timber harvests within the Puget Sound Basin modify habitats and alter habitat forming processes, which in turn threaten terrestrial and freshwater ecosytems and associated assemblages of species.

Figure 11. Regional Threat Rating Summary: Large Scale Timber Harvest



4.12 Military Exercises

Overall Regional Threat Rating:

Threat Definition:

This threat class includes:

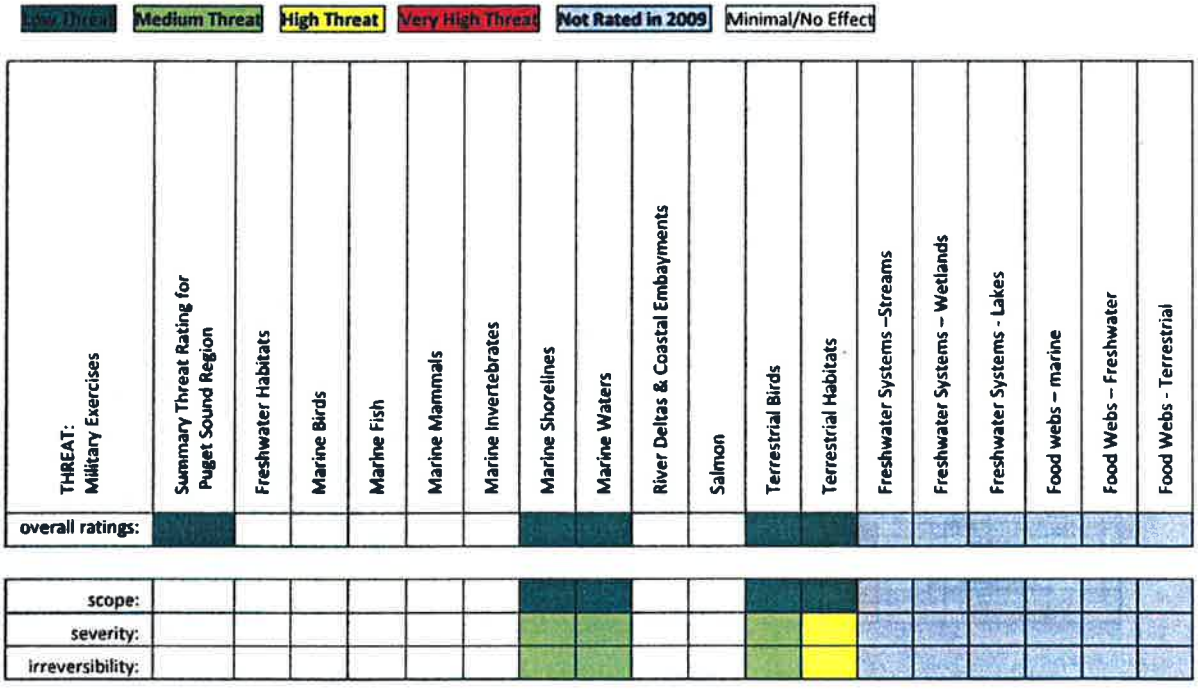
- land-based maneuvers and training with tanks and other military vehicles
- defoliation
- munitions testing
- underwater detonations and submarine maneuvers

This threat class does not include the impervious surfaces and development associated with permanent military bases; these are captured within the residential, commercial, port and shipyard threat class.

Threat Rating Comments:

The direct threat posed by military exercises to marine waters, marine shorelines, terrestrial habitats and birds is low and is assumed to have a notably small geographic extent. The region currently lacks a comprehensive understanding of the spatial and temporal extent of military exercises throughout the basin; threat rating will need to be updated to reflect emerging status/trends information over time.

Figure 12. Regional Threat Rating Summary: Military Exercises



4.13 Mineral and Gravel Mining

Overall Regional Threat Rating:

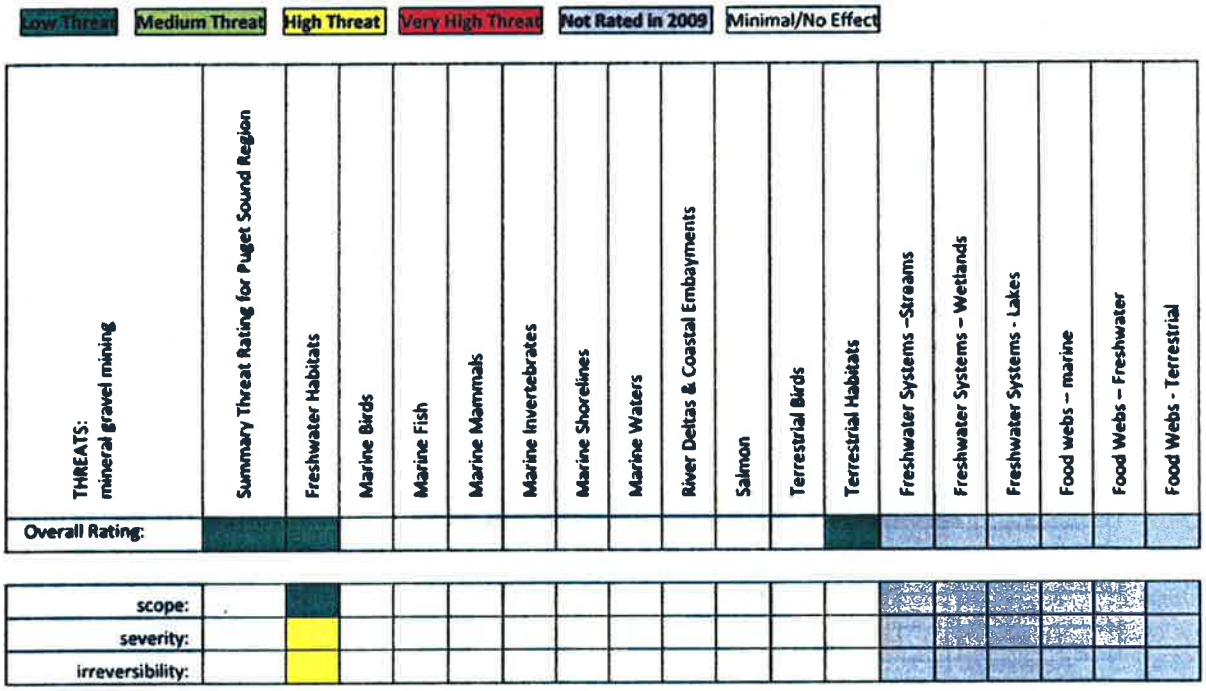
Threat Definition: This threat class includes:

- exploring for, developing and producing minerals and rocks (quarries, gold, etc)

This threat class does not include extraction of gravel from river or stream beds

Threat Rating Comments: This threat was rated low for its direct effect upon ecological components; ratings were not intended to capture the positive societal values gained from mineral and gravel mining. This direct threat is governed by laws and regulations, which when enforced, provide protection for the freshwater and terrestrial habitats potentially affected by mineral and gravel mining.

Figure 13. Regional Threat Rating Summary: Mineral and Gravel Mining



4.14 Oil and Hazardous Spills

Overall Regional Threat Rating: Medium

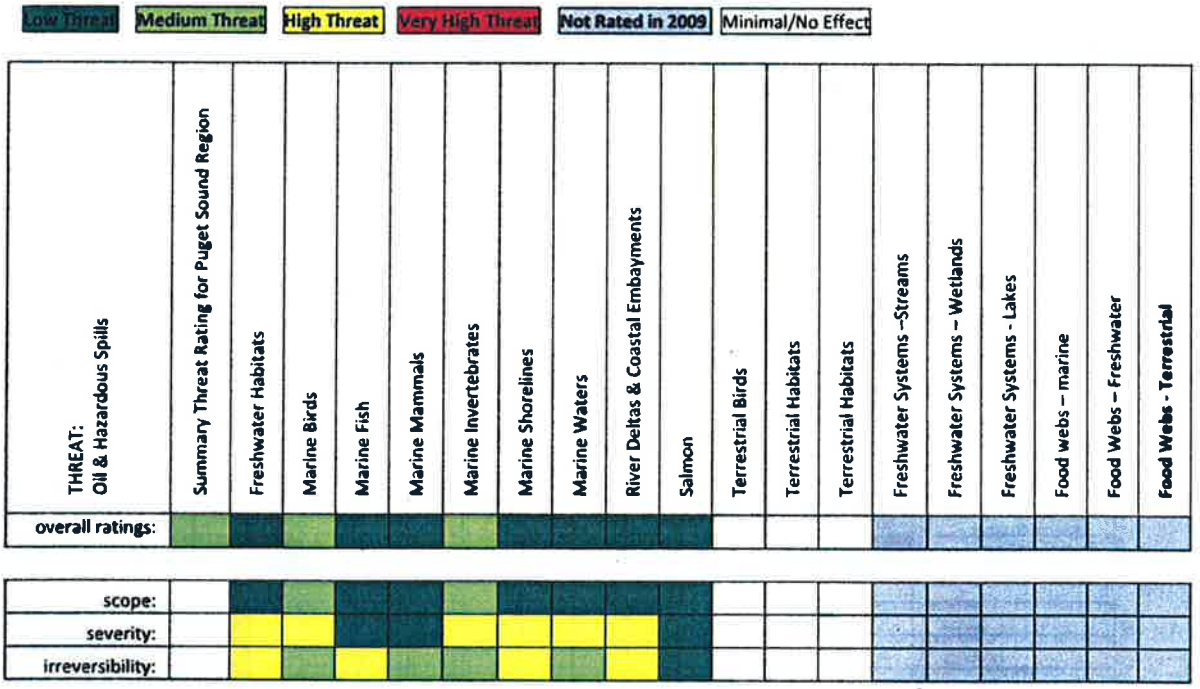
Threat Definition: This threat class includes:

- accidents on land and water that result in water-borne pollutants or toxics in natural systems

This threat class does not include pollutants from stormwater, wastewater treatment plants, CSOs, or other contaminant sources

Threat Rating Comments: Oil spills and hazardous spills impact primarily freshwater and marine ecosystems and was rated as a medium direct threat for the Puget Sound region.

Figure 14. Regional Threat Rating Summary: Oil Spills



4.15 Onsite Sewage Systems

Overall Regional Threat Rating: Medium

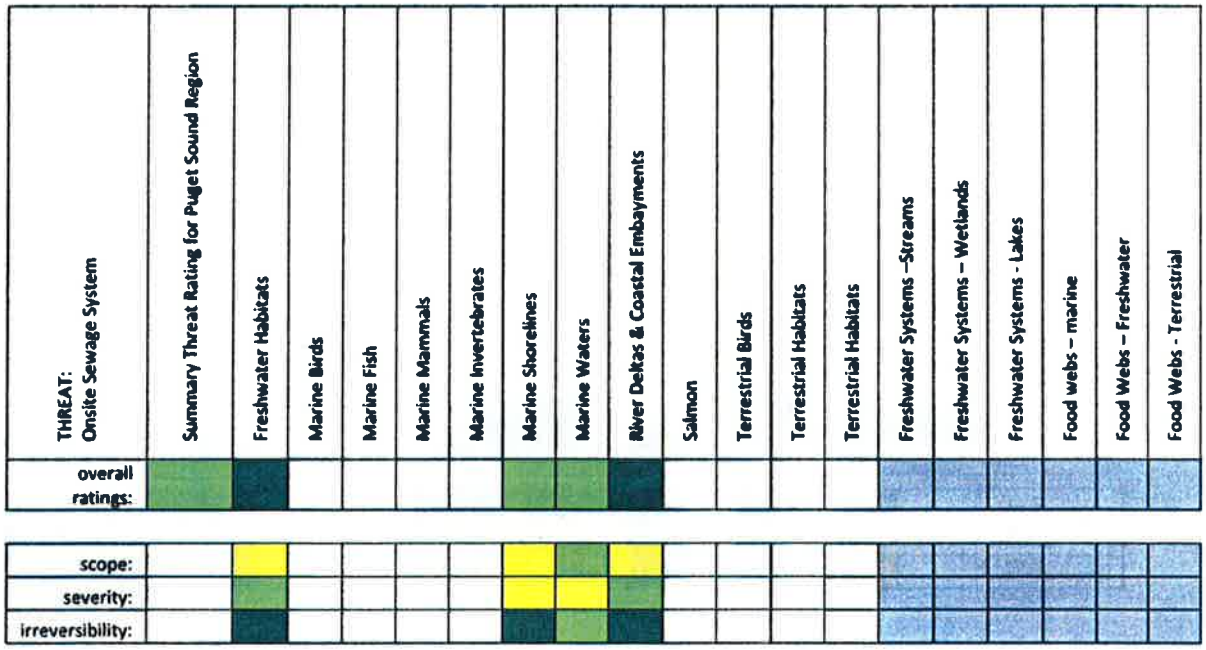
Threat Definition: This threat class includes:

- sewage and leachates from residences not connected to a municipal system (septics, small private systems and everything with a drain field)
- nutrients, toxic chemicals and/or sediment from these onsite systems

Threat Rating Comments: This threat was rated medium for its direct effect upon ecological components; ratings were not intended to capture the positive societal values gained from onsite sewage systems. Poorly functioning onsite sewage systems primarily threaten freshwater and marine ecosystems within Puget Sound. Though this direct threat was rated medium at a Puget Sound scale, in some Action Areas (or other sub-regional units) this direct threat may be higher given associated water quality problems that are directly attributable to this threat.

Figure 15. Regional Threat Rating Summary: Onsite Sewage Systems

Low Threat | Medium Threat | High Threat | Very High Threat | Not Rated in 2009 | Minimal/No Effect



4.16 Point Source Pollution

Overall Regional Threat Rating:

Threat Definition:

This threat class includes:

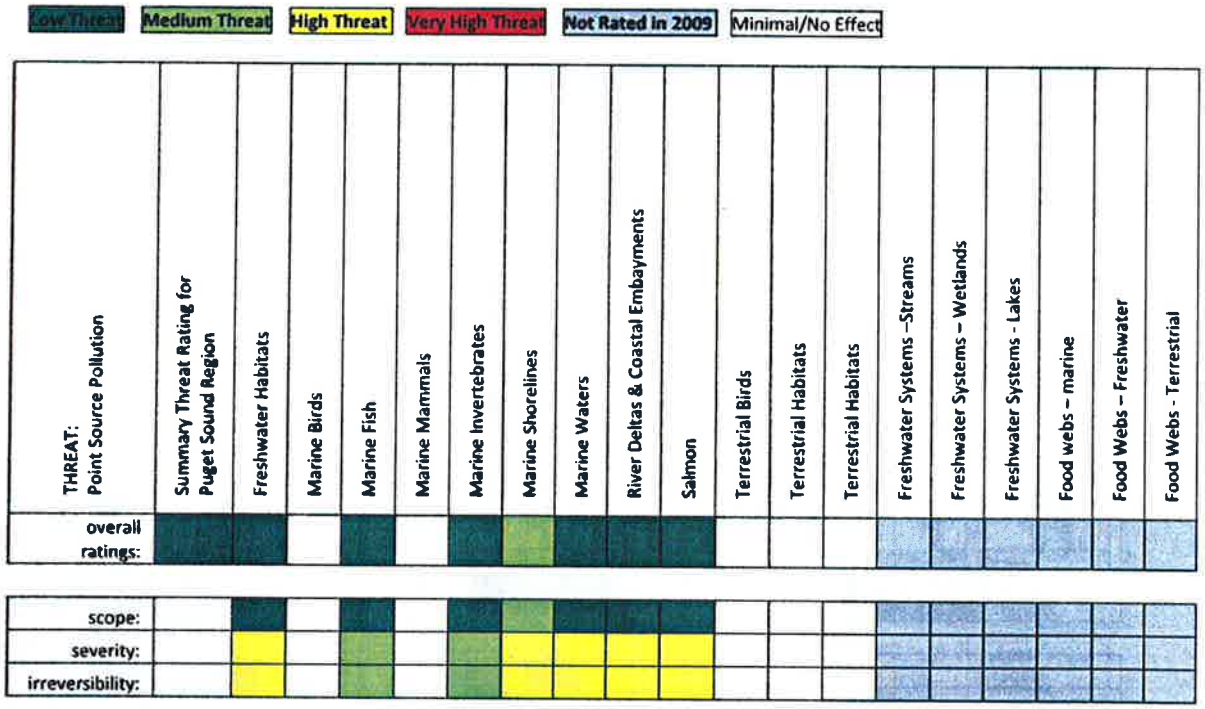
- industrial, military and commercial point source pollution
- cruise ships and other commercial & industrial boat discharge
- legacy toxic sites in the marine and near-shore environments

This threat class does not include surface water runoff, wastewater discharge, or air emissions

Threat Rating Comments:

Sources of point source pollution are governed by many laws and regulations within Puget Sound. So long as these laws and regulations continue to be enforced and current funding levels are maintained, this direct threat is rated low for the Puget Sound Basin.

Figure 16. Regional Threat Rating Summary: Point Source Pollution



4.17 Recreational Activities

Overall Regional Threat Rating: Medium

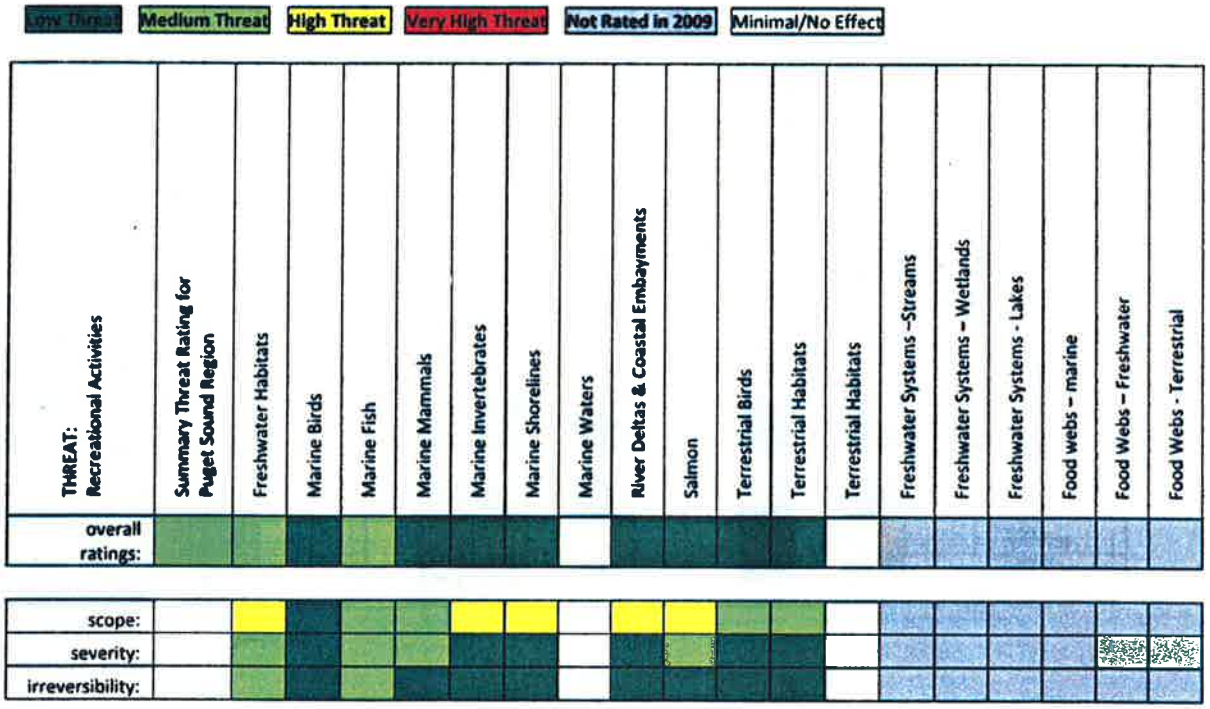
Threat Definition: This threat class includes:

- nature-based recreational activities such as hunting, recreational fishing, beach access, hiking, cross-country skiing, mountain bicycling, rock climbing, bird watching, camping and swimming

This threat class does not include commercial whale-watching, commercial recreational activities or recreational boat discharge

Threat Rating Comments: This threat was rated medium for its direct effect upon ecological components; ratings were not intended to capture the positive societal values gained from recreational activities. Recreational activities take place throughout the Puget Sound Basin and are a direct threat to terrestrial, freshwater, and marine ecosystems.

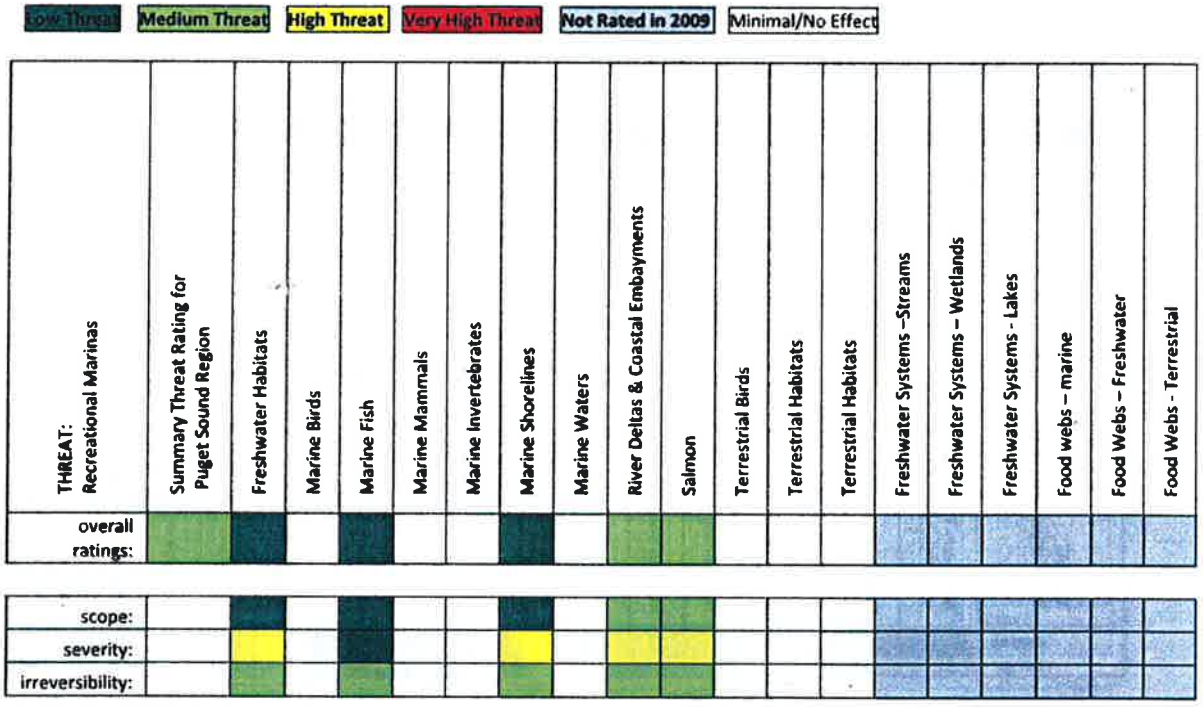
Figure 17. Regional Threat Rating Summary: Recreational Activities



4.18 Recreational Marinas

Overall Regional Threat Rating:	Medium
Threat Definition:	This threat class includes: • marinas, jetties, docks, piers and other compact footprint structures This threat class does not include hull-cleaning and other NPDES regulated activities that occur in marinas
Threat Rating Comments:	This threat was rated medium for its direct effect upon ecological components; ratings were not intended to capture the positive societal values gained from recreational marinas. Recreational marinas pose a direct threat to freshwater and marine habitats, species and foodwebs.

Figure 18. Regional Threat Rating Summary: Recreational Marinas



4.19 Residential, Commercial, Port and Shipyard Development

Overall Regional Threat Rating: Very High

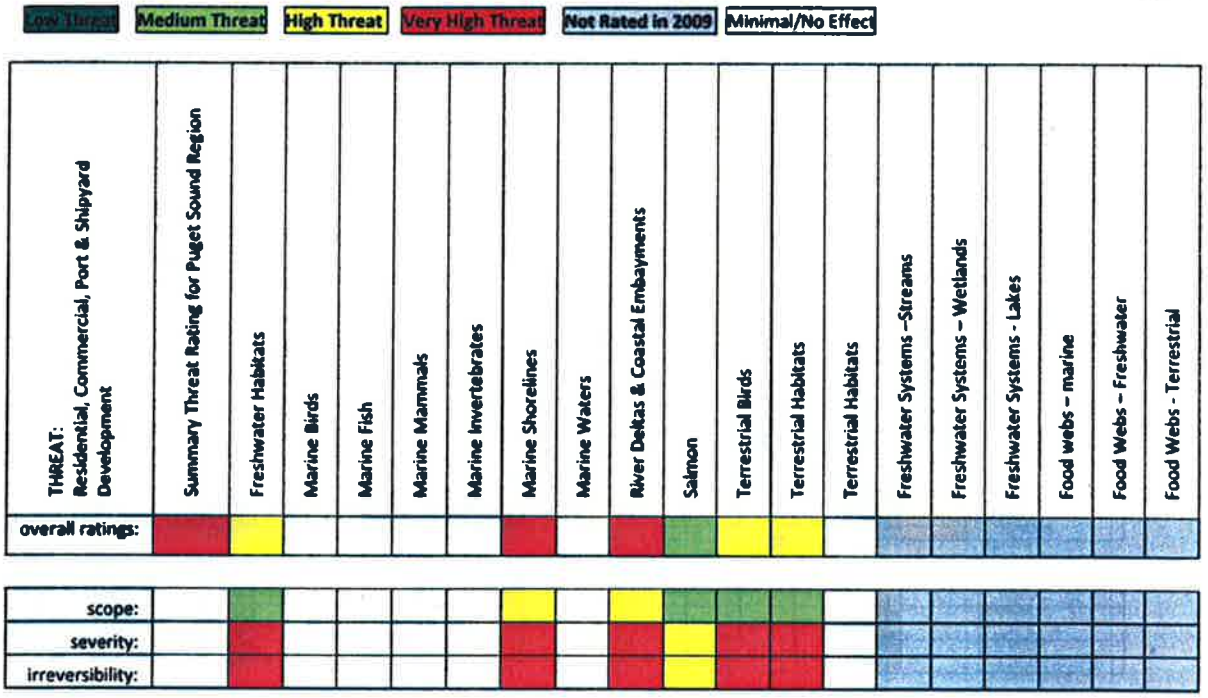
Threat Definition: This threat class includes:

- developed portions of the environment, or other non-agricultural land uses with a substantial footprint, such as those associated with residential, commercial, and industrial land uses
- landfills, ports, military shipyards, and log rafting (only habitat destruction)

This threat category does not include transportation infrastructure or run-off generated from developed portions of the environment

Threat Rating Comments: This threat was rated very high for its direct effect upon ecological components; ratings were not intended to capture the positive societal values gained from residential, commercial, port and shipyard development. Developed portions of the Puget Sound Basin are significant in scale and size and alter terrestrial, freshwater and marine habitats, habitat forming processes and foodwebs. Impacts to ecosystems from this direct threat are often irreversible or prohibitively costly to restore.

Figure 19. Regional Threat Rating Summary: Residential, Commercial, Port and Shipyard Development



4.20 Roads, Transportation and Utility Infrastructure

Overall Regional Threat Rating: High

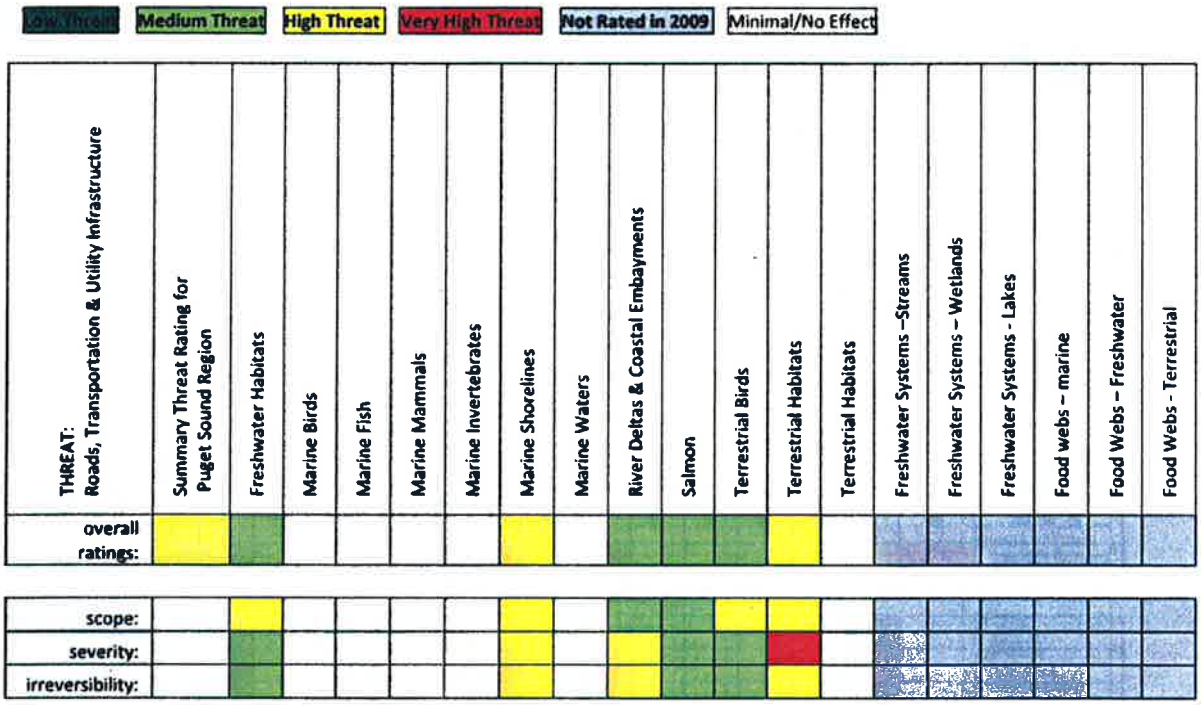
Threat Definition: This threat class includes:

- surface transport on roadways and dedicated tracks
- long narrow transport corridors and the vehicles that use them
- transport of energy and resources
- effects of construction on habitat, including ongoing fragmentation

This threat class does not include: forest logging roads, ancillary roads in urban areas, shoreline armoring runoff, effluent, or air emissions.

Threat Rating Comments: This threat was rated high for its direct effect upon ecological components; ratings were not intended to capture the positive societal values gained from roads, transportation and utility infrastructure. Roads, transportation and utility infrastructure alter terrestrial, freshwater and marine habitats, habitat forming processes and foodwebs throughout Puget Sound Basin. Impacts to ecosystems from this direct threat are often prohibitively costly to restore.

Figure 20. Regional Threat Rating Summary: Roads, Transportation and Utility Infrastructure



4.21 Shoreline Armoring

Overall Regional Threat Rating: High

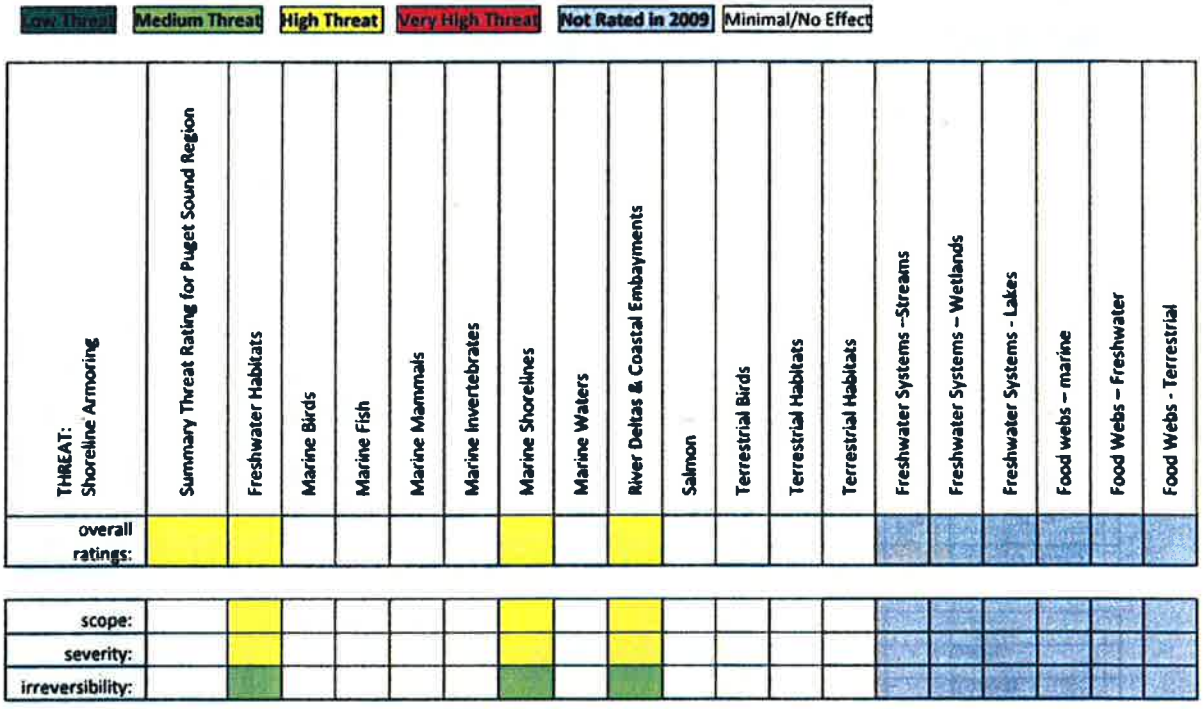
Threat Definition: This threat class includes:

- bulkheads, riprap and other linear shoreline modifications associated with roads, railroads, residential development
- near-shore and freshwater shoreline armoring which supports transportation and utility ROWs

This threat class does not include: flood control shoreline armoring (levees and revetments). The footprints associated with transportation and utility ROWs are included within the Transportation and Utility Infrastructure threat class; this threat class includes only the shoreline armoring, which often supports those ROWs.

Threat Rating Comments: This threat was rated high for its direct effect upon ecological components; ratings were not intended to capture the positive societal values gained from shoreline armoring. Shoreline armoring directly alters freshwater, marine and estuarine habitat and habitat forming processes throughout Puget Sound Basin.

Figure 21. Regional Threat Rating Summary: Shoreline Armoring



4.22 Surface Water Loading and Runoff from the Built Environment

Overall Regional Threat Rating: High

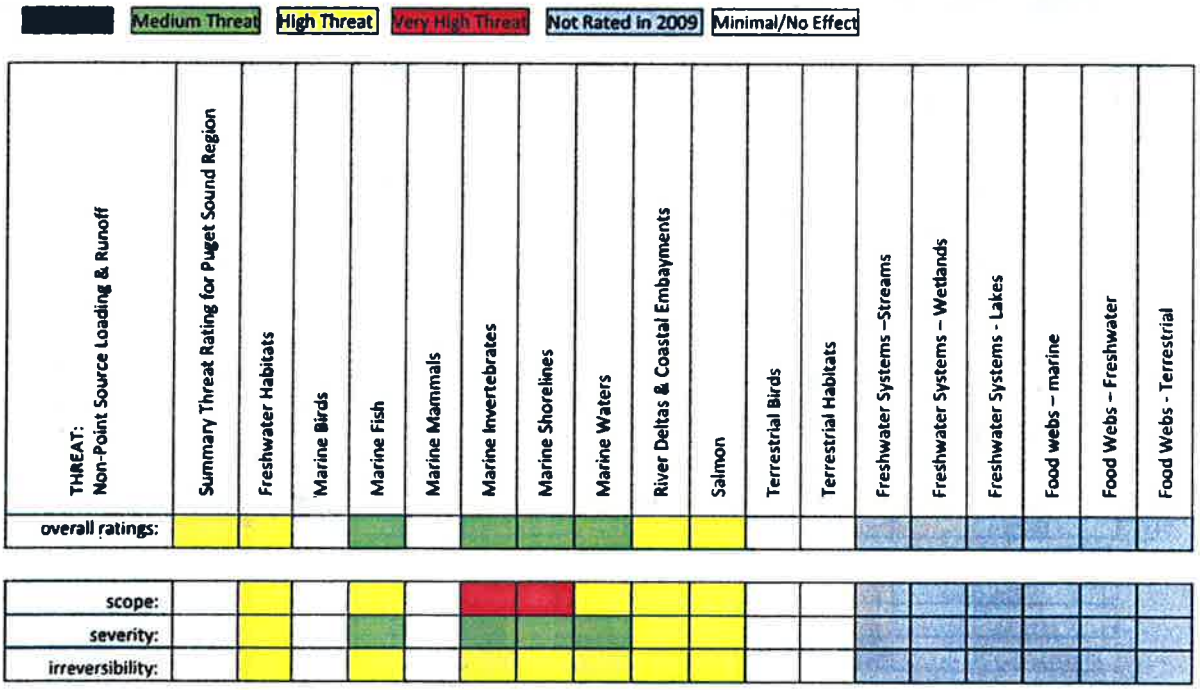
Threat Definition: This threat class includes:

- activities regulated by NPDES
- stormwater water runoff, including toxics, nutrients, pathogens, etc., runoff from roads, rail corridors and transportation infrastructure
- non-point source pollution from marina infrastructure & land-based recreational boat maintenance practices
- best management and containment practices for residential, commercial, and industrial land uses

This threat class does not include loading from septic systems, agriculture or forestry practices.

Threat Rating Comments: Surface-water loading and runoff from the built environment directly threatens freshwater, marine and estuarine ecosystems throughout Puget Sound Basin. This direct threat is rated high due to the volume of runoff and associated contaminant loading which alters habitat, foodwebs and habitat forming processes. Existing laws and regulations govern the design of systems to manage surface water loading/runoff for new development; this threat rating reflects an absence of comparable mandates to retrofit existing developed areas for the purposes of a reduction in stormwater volume and contaminants from the built environment.

Figure 22. Regional Threat Rating Summary: Surface Water Loading and Runoff from the Built Environment



4.23 Unsustainable Fishing and Harvest

Overall Regional Threat Rating: High

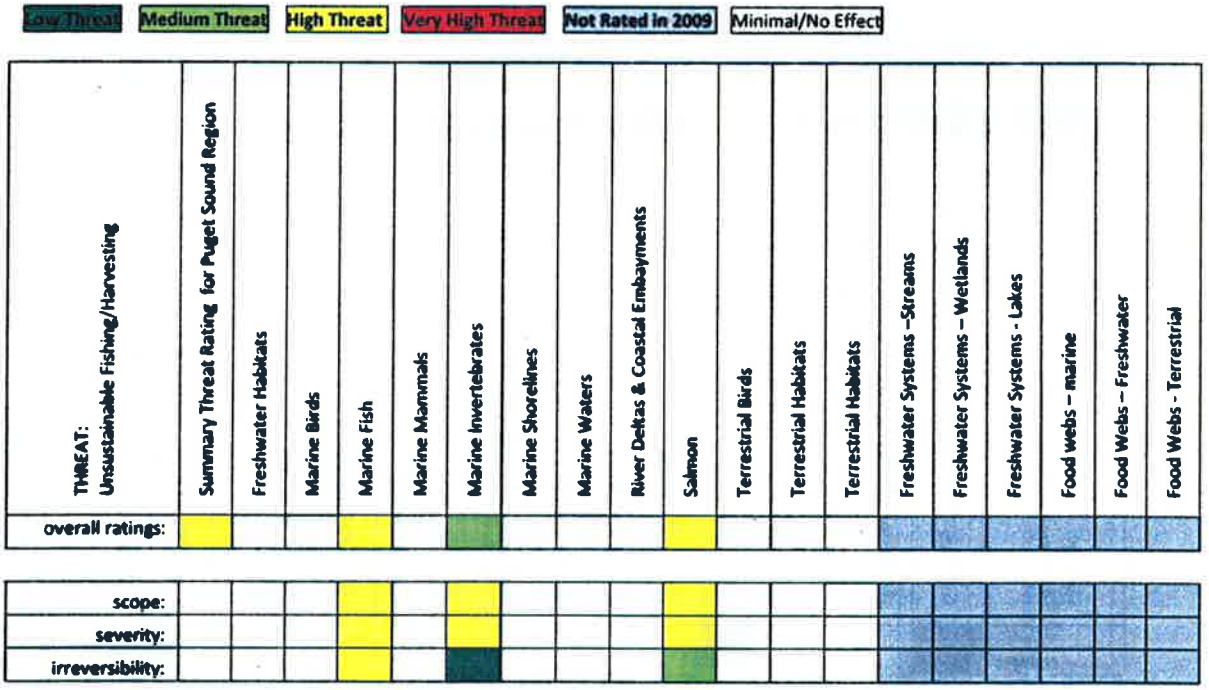
Threat Definition: This threat class includes:

- overharvesting and bycatch of fish and shellfish from both legal and illegal practices
- marine/freshwater habitat destruction from fishing practices

This threat class does not include derelict gear or recreational fishing

Threat Rating Comments: This threat was rated high for its direct effect upon ecological components; ratings were not intended to capture the positive societal values gained from fishing and harvest. Unsustainable fishing and harvest directly threatens marine fish, marine invertebrates, salmon and associated foodwebs throughout the Puget Sound Basin.

Figure 23. Regional Threat Rating Summary: Unsustainable Fishing and Harvest



4.24 Vessel Traffic and Interaction

Overall Regional Threat Rating: [redacted]

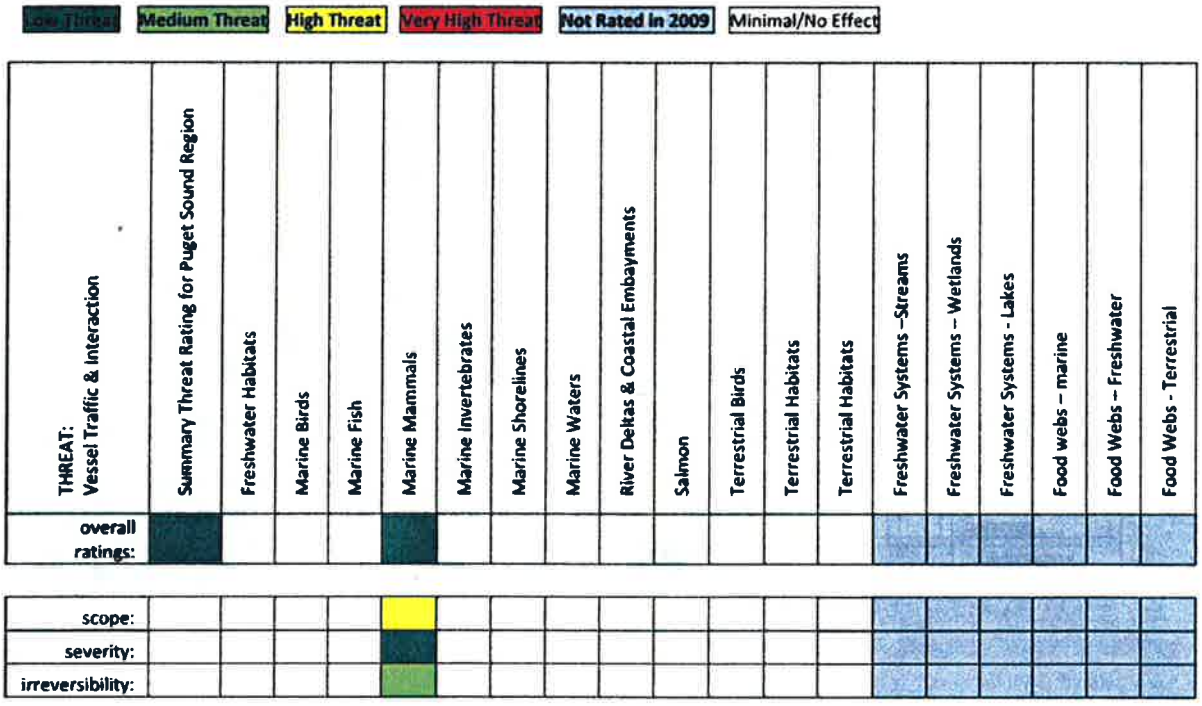
Threat Definition: This threat class includes:

- commercial transport and tourist ships on and in freshwater and marine waterways
- shipping lanes
- commercial whale-watching vessels
- wakes from cargo ships
- anchor damage from dive boats

This threat class does not include recreational boating in freshwater and marine waterways.

Threat Rating Comments: This threat was rated low for its direct effect upon ecological components; ratings were not intended to capture the positive societal values gained from vessel traffic and interaction. The Puget Sound Basin supports shipping lanes for container ships, cruise ships and other marine industrial activities. Vessel traffic and interaction directly threaten marine ecosystems, including the species and foodwebs supported by healthy marine waters, in the vicinity of shipping lanes, ports and marine industry terminals.

Figure 24. Regional Threat Rating Summary: Vessel Traffic and Interaction



4.25 Wastewater Treatment Plant Discharge and CSOs

Overall Regional Threat Rating: [redacted]

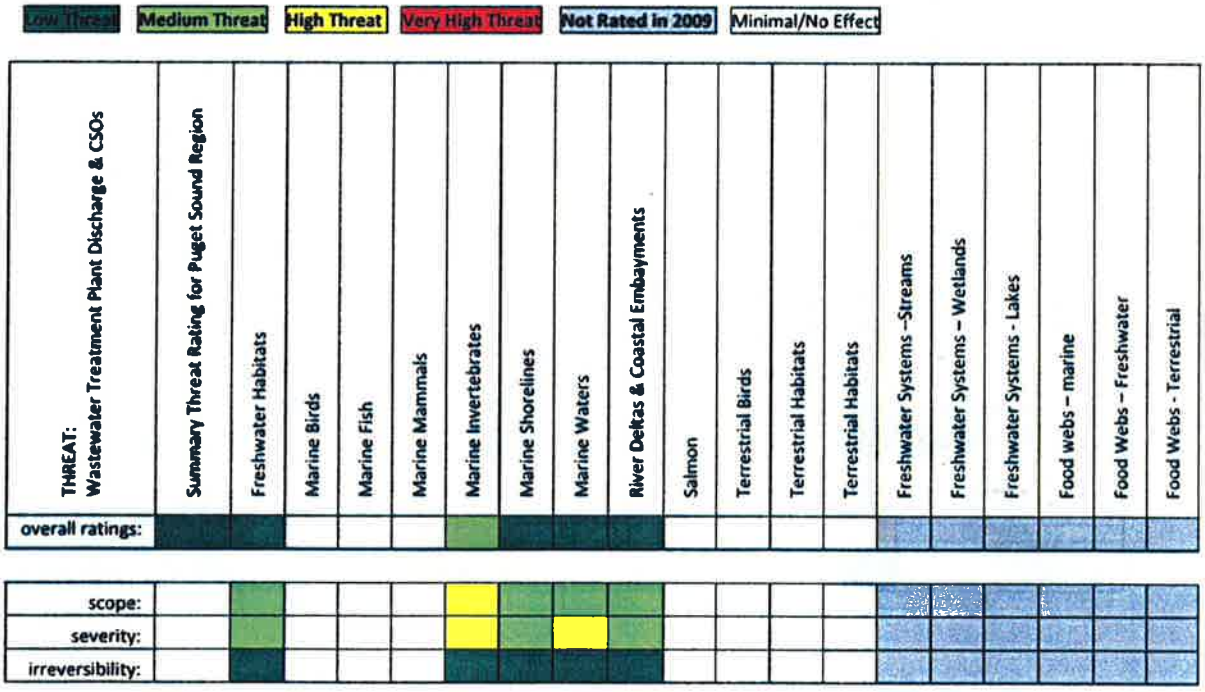
Threat Definition: This threat class includes:

- water-borne sewage from housing and urban areas that include nutrients, toxic chemicals, pathogens and/or sediments
- Municipal wastewater treatment facilities
- Combined sewer overflows (CSOs)

This threat class does not include bio solids applied in terrestrial environments.

Threat Rating Comments: The potential for this threat to affect Puget Sound is significant. Wastewater treatment discharge and combined sewer overflows (CSOs) are governed by many laws and regulations within Puget Sound. So long as these laws and regulations are enforced and current funding levels are maintained, this direct threat is rated low for the Puget Sound Basin. The low threat rating does not reflect levels of uncertainty regarding the effectiveness of current municipal wastewater treatment in addressing endocrine disruptors and other emerging contaminants/toxics.

Figure 25. Regional Threat Rating Summary: Wastewater Treatment Plant Discharge and CSOs



4.26 Water Withdrawals and Diversions

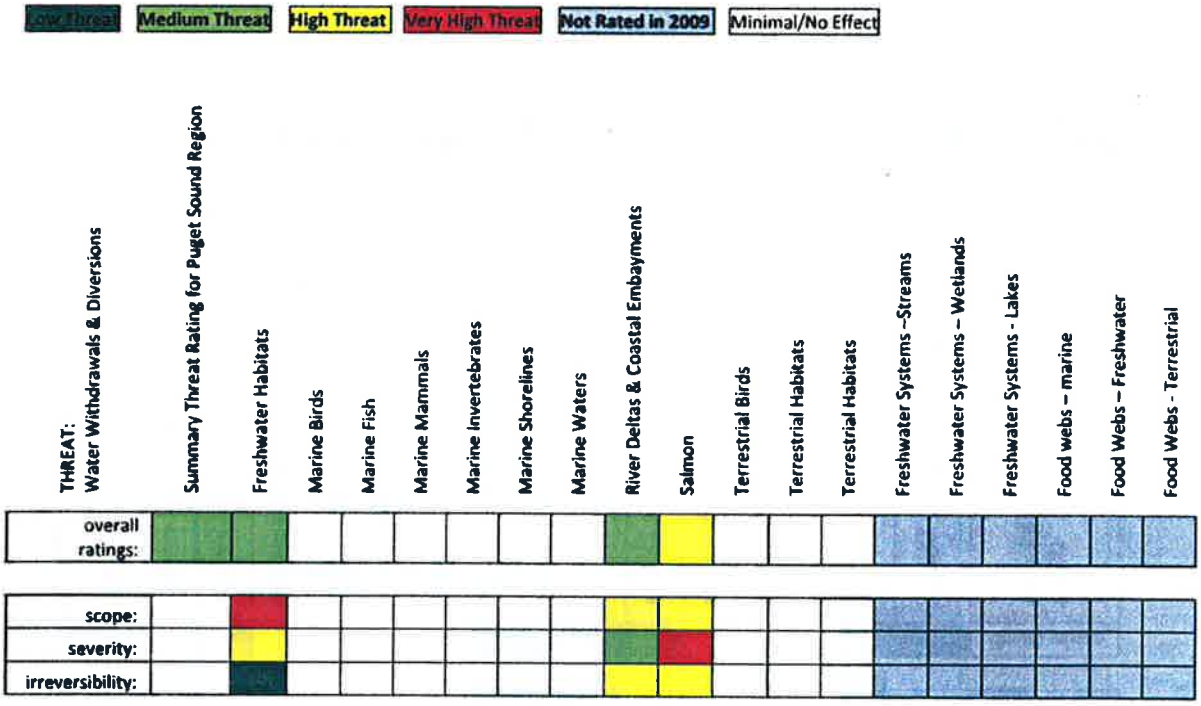
Overall Regional Threat Rating: Medium

Threat Definition: This threat class includes:

- extraction and diversion of water in support of residential, industrial, commercial and other rural and municipal uses
- changing water flow patterns, such as instream flows, from their natural range of variation either deliberately as a result of water supply or flood management operations

Threat Rating Comments: This threat was rated medium for its direct effect upon ecological components; ratings were not intended to capture the positive societal values gained from water withdrawals and diversions. Water is withdrawn and diverted in many locations throughout the Puget Sound Basin thereby impacting freshwater resources that are necessary to support freshwater, estuarine and salmonid habitats and habitat-forming processes.

Figure 26. Regional Threat Rating Summary: Water Withdrawals and Diversions



5. Next Steps and Recommendations

This technical memorandum presents the current state of efforts to identify and rate, at the regional scale, threats to the Puget Sound, as a basis for informing future funding, policy and program decisions supporting the implementation of the Action Agenda. The Partnership anticipates building upon this work to inform development of a comprehensive Action Agenda performance management system, as well as to provide shorter-term budget guidance to the state agencies and other implementers in May 2010. Anticipated next steps for this work include:

- Receive and synthesize feedback on the 2009 threats rating technical memorandum.
- Address the need to rate threats relevant to the six components that were identified after the initial rating exercise was completed.
- Provide the initial threat rating results and the feedback as input to development of the Puget Sound Science Update, and work with the Science Update team to complete a comprehensive threat rating.
- Provide public review of the next iteration of threat rating, done through or in conjunction with the Science Update project.
- Identify key research gaps associated with threats information and work with the Science Panel to incorporate into the Biennial Science Work Plan.
- Release the comprehensive threat rating with the Science Update; incorporate that material into the Action Agenda performance management system and the assessment of Action Agenda progress.